



Installation Manual

Femtogrid Solar System: the sunny side of shade

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1. Explanation of the symbols used

To ensure optimal usage of this document, we start by explaining the symbols used in this installation manual for the inverter.



This symbol indicates an example.



This symbol indicates a note, which, if ignored, will make the procedure or operation more difficult.




This symbol indicates a fact, which, if not observed, could result in damage to components or represents danger to persons. Read these passages carefully.

2. Introduction

General

Thank you for buying this product and helping the world to be a greener place by adding a sustainable energy system to our planet. Your photovoltaic (PV) system produces grid-ready solar energy that contributes to the global reduction of CO₂ emission and stimulates the transition from conventional fossil energy sources to renewable energy sources in our demand for energy.

Target group document

 Authorized installers must install this product. In addition, the installer must follow the regulations of the local grid operator. The installer must read this installation guide carefully and must ensure compliance with all prescribed safety regulations, the technical connection requirements of the local grid operator and any other applicable provisions.

Introduction to the Femtogrid Solar System

The Femtogrid Solar System consist of the following parts:

- PV modules
- Power Optimizer for every PV module
- Inverter 2200
- DC Cables & Connectors
- Monitoring (wireless monitoring system) consisting of a Monitoring Box and a Monitoring Portal

Together with the PV modules and its mounting material the Femtogrid Solar System forms a complete PV system that due to its innovative features has some important benefits over the traditional PV systems.

One of the distinguishing features of the Femtogrid Solar System is the fact that it is now possible to connect, in one PV system to the grid, PV modules of different quality in terms of:

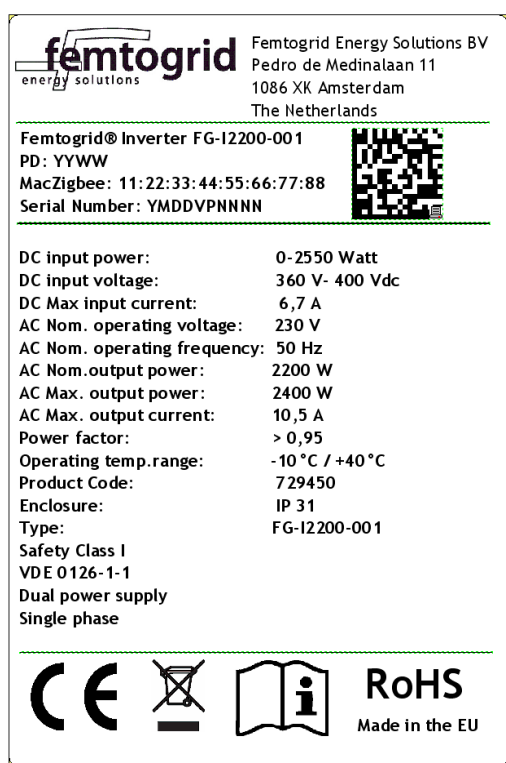
- type of module (e.g. mono- or polycrystalline)
- power output (e.g. 185 Wp or 235 Wp)
- power tolerance (e.g. -5 Wp / +10 Wp)
- open circuit voltage (e.g. 30 Voc or 40 Voc)
- cell technology and number of cells
- manufacturer
- aging of the module
- output variation in response to temperature variation
- angle to the sun (e.g. azimuth and the angle of the rooftop used)

Another important feature of the Femtogrid Solar System is the fact that it's **plug & play, safe and efficient**. This is a major advantage and increases the flexibility for installers to install a PV system on a rooftop. It is also a great step forward in terms of rooftop optimization.

Moreover, the Femtogrid Solar System has a big advantage for solar systems at places where PV modules are partly shaded. Here, the power output for shaded PV modules can be higher than for traditional systems using a serial system approach due to smart electronics and a parallel system approach used. As a result, benefits up to 30% can be realized.

Validation document

This document is only valid for inverters with the following nameplate. Keep this guide in a convenient place for future reference.



3. Safety instructions

Installing the Femtogrid Solar System



The installation of the Femtogrid Solar System must be carried out by authorized installers and performed in accordance to local and national regulations (e.g. the regulations for the Netherlands are covered by the NEN1010).



Do not connect the inverter to the DC grid before the total system is installed. The DC grid may be charged up to 400 Vdc when it is connected to the inverter. Do not touch the inside of the connectors



High voltages inside the Power Optimizer and the inverter

Do not open the housing of the inverter or the Power Optimizer. This is not needed for installation and should only be done by authorized installers. Warranty will be void after opening the housing of the Power Optimizer or the inverter.

Femtogrid DC bus safety warnings



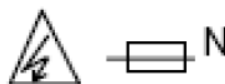
If the Femtogrid female DC connector is disconnected from the inverter, the power of all equipment of the bus (DC grid) will be disconnected. However, if the DC cables or connectors are damaged, it is possible to get electrical shocks.



Place a protection or end cap on the 'OUT' (female DC) on open connectors of Power Optimizers. Normally it is not possible to directly touch the high voltage, but without an end cap, water can get into the connector and can cause malfunction of the system.



CAUTION: DOUBLE POLE / NEUTRAL FUSING



Connection area

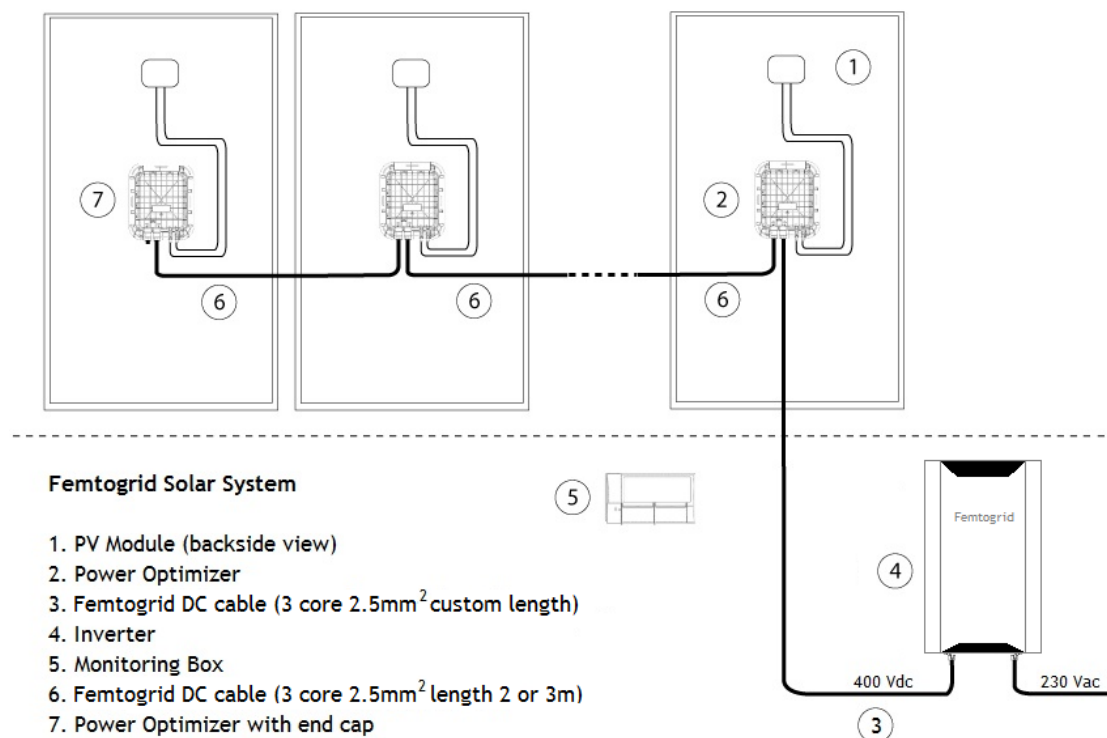
Do not open the Power Optimizer. Dangerous voltages can be inside this device.



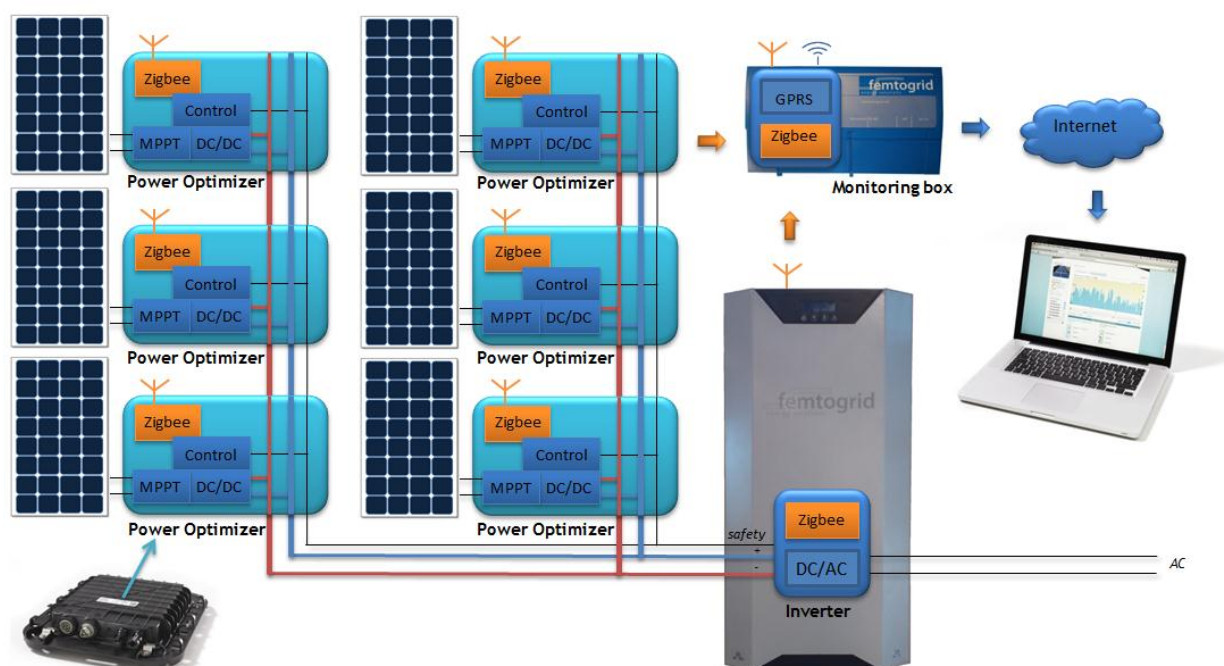
Do not switch on the inverter (AC power) before finishing the installation. The safety switches of the Power Optimizer are activated once the AC power is switched on. The DC bus is then charged to a potentially dangerous voltage.

4. Schematic Femtogrid Solar System

The schematic overview presented below shows all parts of the Femtogrid Solar System:



All Power Optimizers are connected in parallel with the special Femtogrid DC cables, which have 3 wires. These 3 wires enable the parallel network, as shown in the schematic overview displayed below. The data communication is wireless using a Zigbee network and has no influence on the power generation.



5. Short installation sequence



To ensure a safe, quick and easy installation, we advise to follow the following installation sequence:

1. View the mounting construction and decide where to **place the Power Optimizers** on the back of the module. **Do not** mount the Power Optimizer **behind a mounting beam**.
2. **Clean the back of the module** where the Power Optimizer will be attached. Use alcohol or naphtha and a soft cloth.
3. Remove the red covers of the double-sided adhesive tape and **attach the Power Optimizer to the back of the module**.
4. **Lead the Femtogrid DC cable through the fingers** of the Power Optimizer.
5. **Connect the MC4 connectors**.
6. Repeat step 2 till 7 for all modules.
7. **Lead the longer (custom length) Femtogrid DC cable** (inverter cable) into the house, but **do not connect this cable to the inverter**.
8. **Connect the longest Femtogrid DC cable** to the Power Optimizer of the **first solar module** that will be mounted. This module is mounted most nearby the inverter.
9. **Connect the Femtogrid DC cable** that is attached on the module on the remaining connector of the Power Optimizer.
10. **Pull on the remaining cable end** of the Femtogrid DC cable that is fitted in the fingers of the Power Optimizer until you have the right length to connect it to the Power Optimizer of the next module and **fix the module**.
11. **Place the next module and connect the Femtogrid cable of the previous module** on the Power Optimizer.
12. **Repeat steps 10 and 11 till the last module**.
13. **Place an end cab** on the Power Optimizer of the **last module** that will be mounted.
14. **Mount the inverter inside** on a suitable place and **connect the Femtogrid DC cable** (see manual inverter for detailed instructions).
15. If a blue monitoring box is delivered. **Activate the monitoring box**, by **pressing the button** with a small pointy object (e.g. toothpick) **for 5 seconds during power up**.
16. **Assemble the delivered female AC connector** and **connect the inverter to the mains**.
17. **Enter date, select language and country**.
18. When a **monitoring box** is installed, wait till the question “search for network?” appears. **Do not answer “Yes” directly**, but first execute step 19.

If no monitoring box is installed, answer “No” and go to step 21.

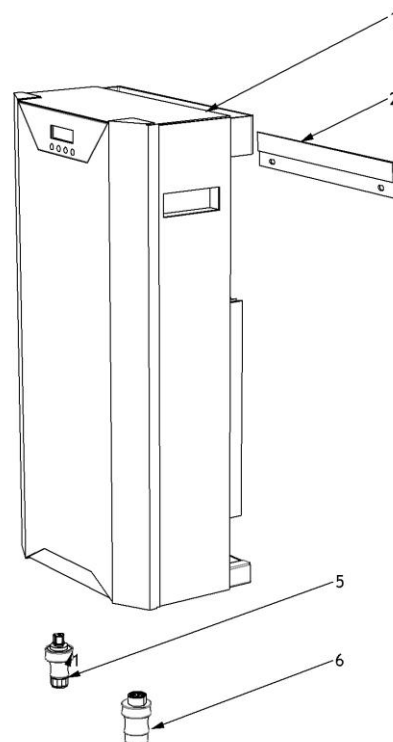
19. **Press the button of the Monitoring Box shortly.** The green led will start to blink for 50 seconds. During this time Power Optimizers and the inverters can enter the network of the Monitoring Box. The Power Optimizers will join automatically to this network. The inverter needs a conformation to join the network.
20. Select **“yes” at the inverter** (question **“search for network?”**) **during** the time the monitoring box has a **green blinking led**. The inverter will search and answer that it has joined the network.
21. **Now the system is installed. Press two times the up button of inverter to check** on the display if **power** is converted, to be sure that the system works properly.
22. To check if the wireless data network is installed, go to: settings menu -> Zigbee network -> node list.

It should show the appropriate number of Power Optimizers, one monitoring box and the number of inverters minus one (it does not see it self).

6. Mechanical installation of the inverter

Check parts

1. Inverter
2. Mounting bracket
3. User manual
4. Installers manual
5. Femtogrid connector
(Used to connect to DC Femtogrid)
6. Wieland connector
(Used to connect to AC grid)



Check for damage of the products



Check the DC cables for damage. Cuts in DC cables or broken DC connectors can cause malfunctioning of the Femtogrid Solar System and may cause dangerous situations. Check the inverter. If damaged, contact your supplier.



Choosing the mounting location

DANGER to life due to fire or explosion.

Despite careful construction, electrical devices can cause fires.

- Do not mount the inverter on flammable construction materials.
- Do not mount the inverter in areas where highly flammable materials are stored.
- Do not mount the inverter in areas with a risk of explosion.



The inverter is only suitable for indoor placement. It is not allowed to place the inverter outside where it is exposed to rain and other weather conditions.



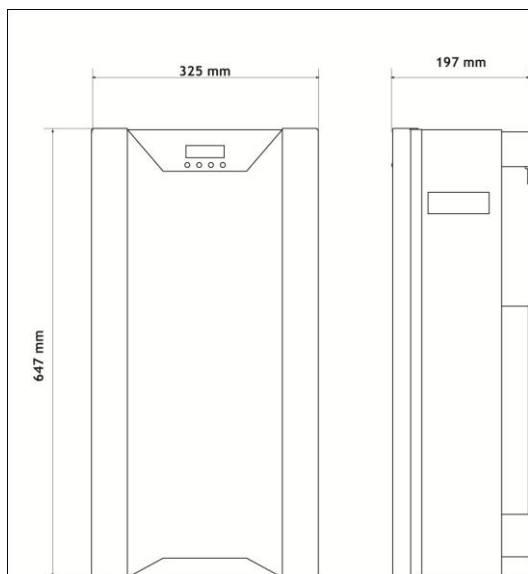
If more inverters are installed be sure that the inverters are not placed above each other. This has a bad influence on the heat dissipation of the inverter.



The installation must be protected by a circuit breaker of 16 A.

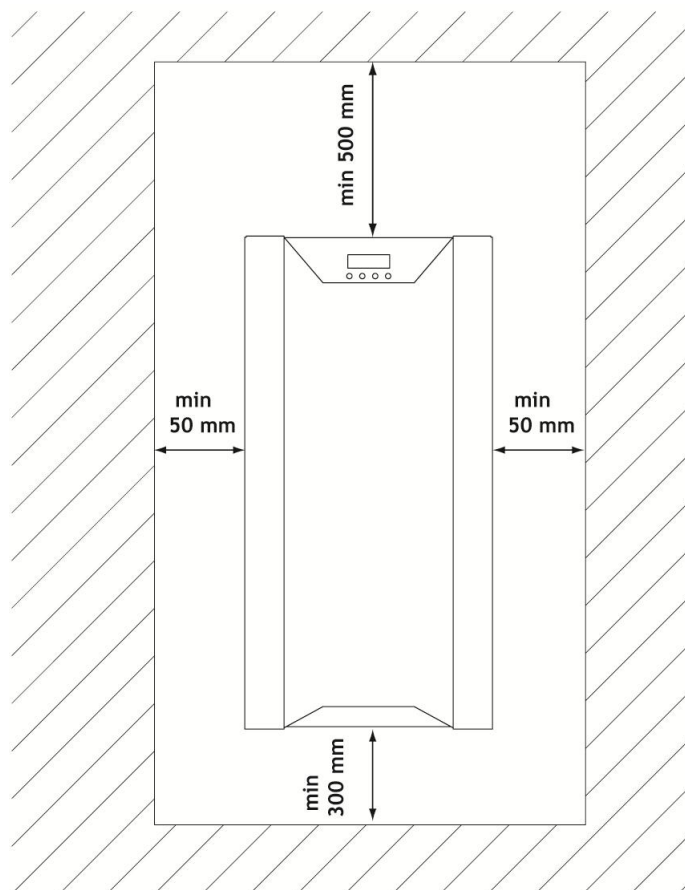
To ensure good wireless communication for the web monitoring portal it is important to place the inverter in range of the wireless network of the Power Optimizers. For example: in the loft right under the roof. If this is not possible, there are two ways to enlarge the range of the wireless network. First mount the Monitoring Box on a strategic place between the Power Optimizers and the inverter. If this doesn't work, additional repeaters are necessary to enlarge the range of the wireless network. For more information on the monitoring system, see the manual of the Monitoring Box. The inverter and Power Optimizers do not need the wireless network to convert the energy properly.

Dimensions



Mounting the inverter onto the wall

Choose a place that allows the inverter to conduct its heat. A range of 50 cm above the inverter must be clear of obstacles.



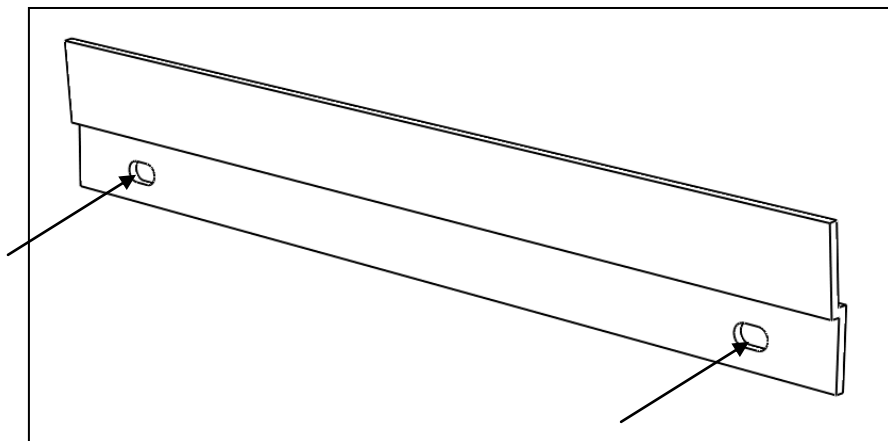
Make sure the inverter hangs vertically. Do not place the inverter horizontally.

Mounting instructions

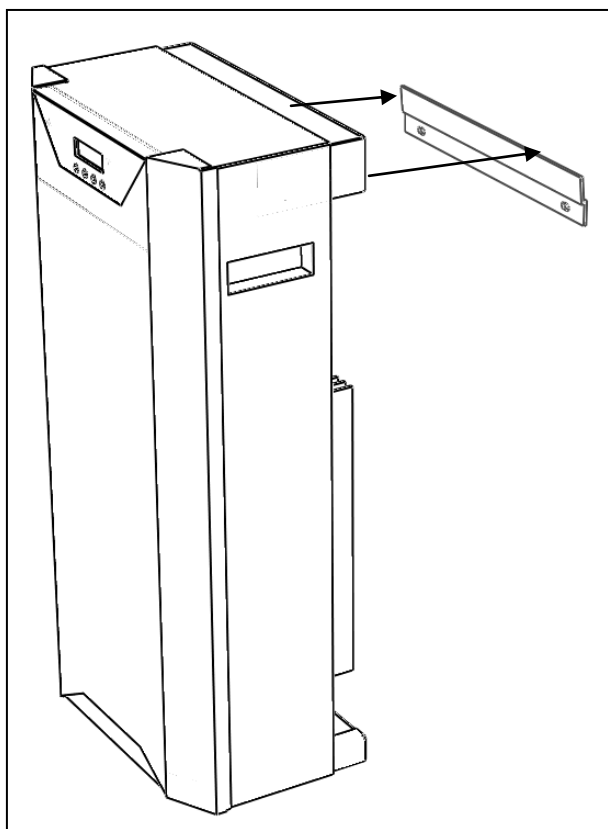
Screws and plugs are not included. Each wall needs different screws and plugs to ensure a solid fixation.

Take the weight of the inverter in account when choosing the appropriate mounting material. The weight of the inverter is $\pm 38\text{kg}$.

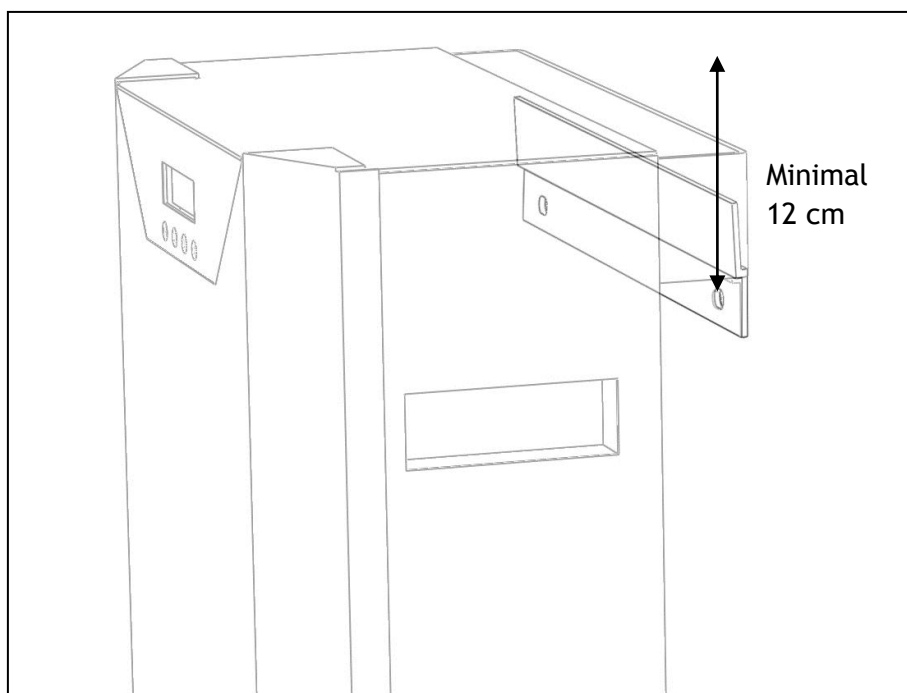
1. Use the mounting plate to mark the drill holes on the wall.



2. Attach the mounting plate to the wall using appropriate screws and washers.
3. Place the inverter on the mounting plate.

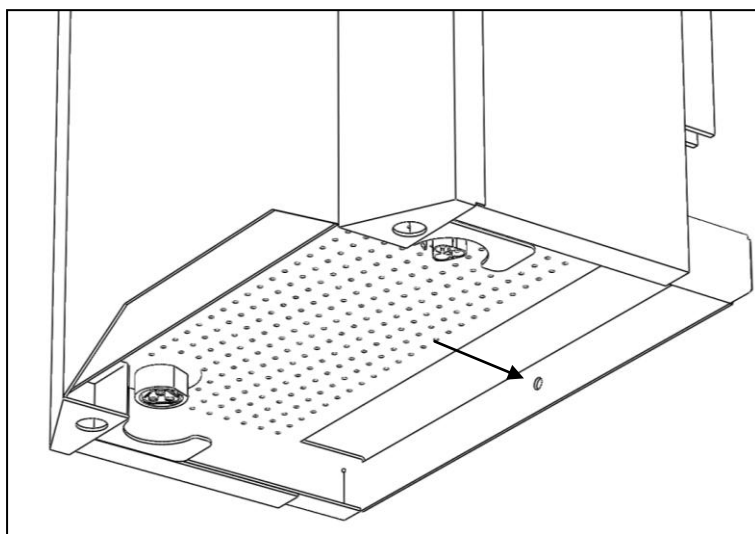
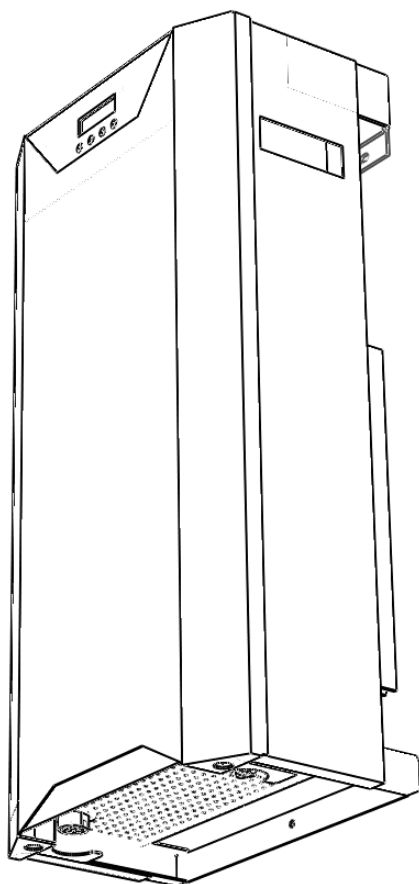


4. Check if the inverter is correctly aligned on the mounting plate.



5. Use the inverter to mark the drill hole on the wall.

6. Lock the inverter with a screw on the bottom.



7. Connection area



Do not open the inverter during the installation.



Do not switch on the AC power before finishing the installation.

The safety switches of the Power Optimizer are activated when the AC power is switched on. The DC bus can be charged to a potentially dangerous voltage.



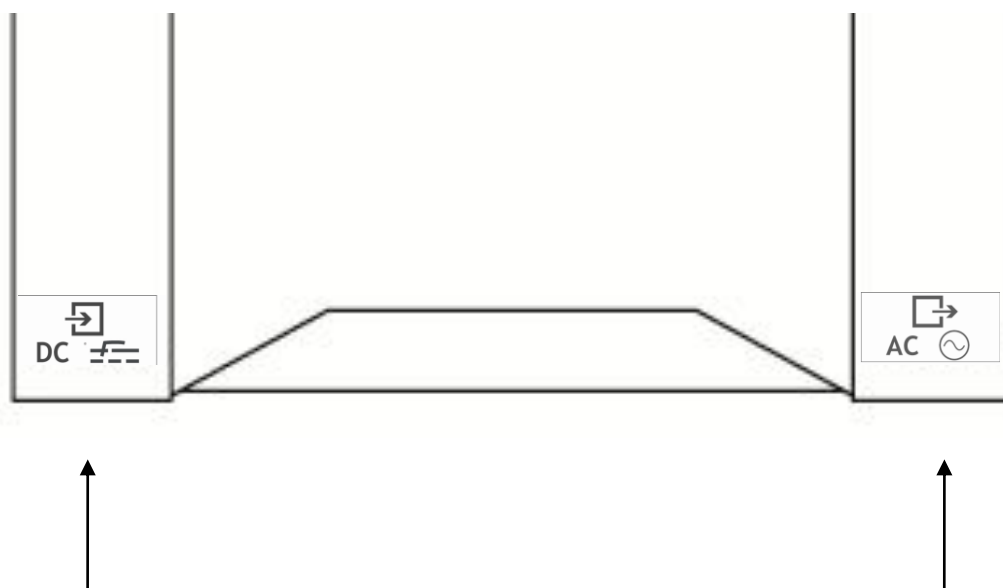
Use of the special Femtogrid cable is prescribed for this installation. This cable is specified for outdoor use.

Materials: According to TÜV 2 Pfg 1169/08.2007.

Insulation: Special XL-HFFR compound.

Conductor: Tinned copper conductor according to class 5 of IEC 60228.

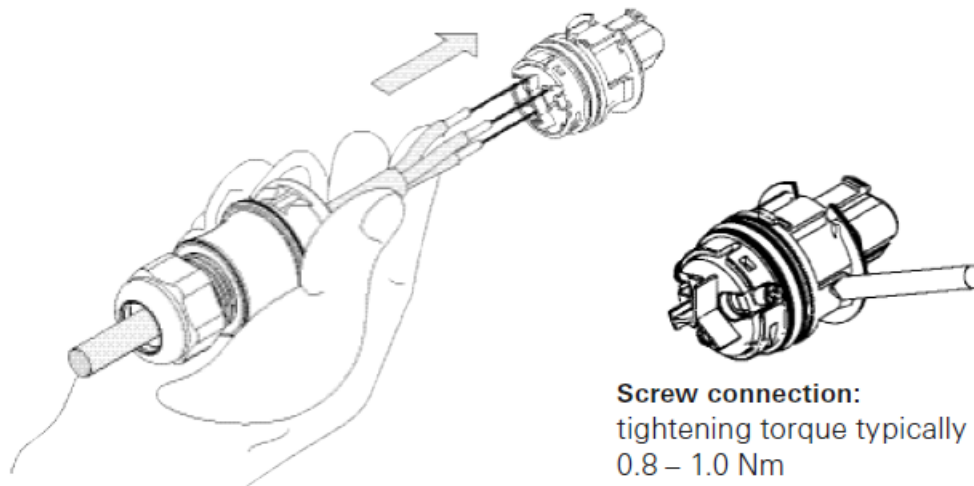
The inverter has two connection points.



The connectors that fit on these connection points are delivered with the inverter.

Assemble the AC cable connector

Connect the AC cable socket with a flexible cable according to EN60309-2/VDE 0623. Strands with a cross-section of minimal 2.5 mm² to maximal 4 mm² can be connected.



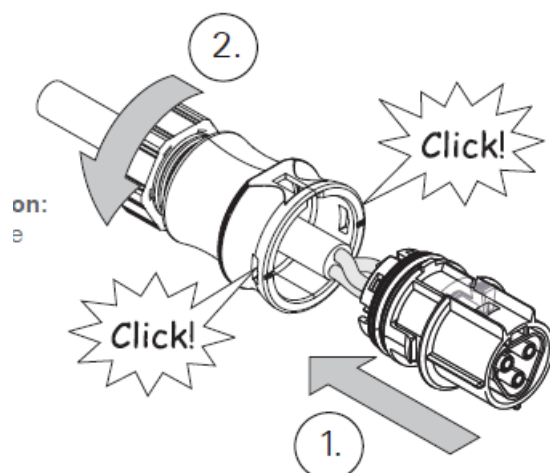
Push the rear part of the socket over the cable.
Press wire end sleeves onto the stripped strands.

Connect the individual wires as follows:

- **Protective earth** conductor PE with the screw terminal with **earth symbol**
- **Neutral** conductor N on screw terminal with the label **N**
- **Phase L** on screw terminal with the label **L**

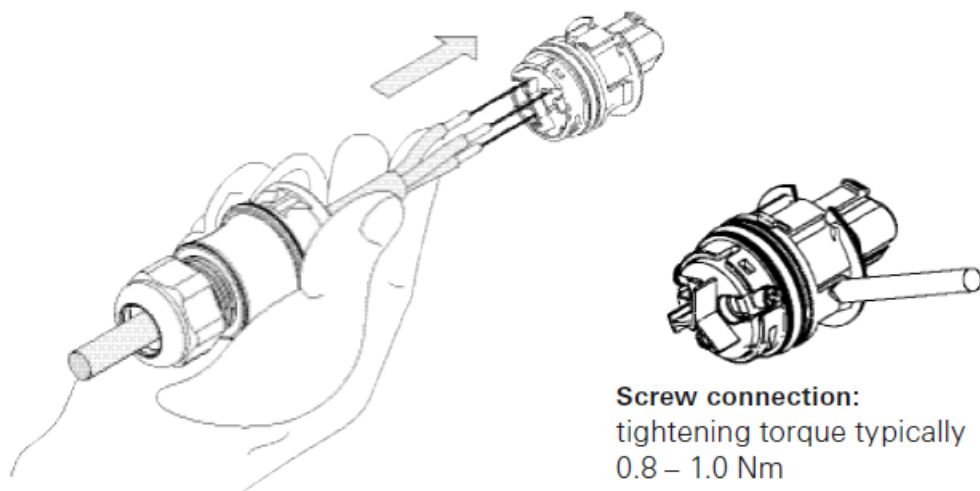


Ensure that the wires are connected properly.
Snap the rear part of the socket onto the socket insert and tighten the screwed cable gland.



Assemble the FemtoGrid DC cable connector

Connect the FemtoGrid DC cable socket with the special FemtoGrid DC cables. Strands with a cross-section of minimal 2.5 mm² to maximal 4 mm² can be connected.



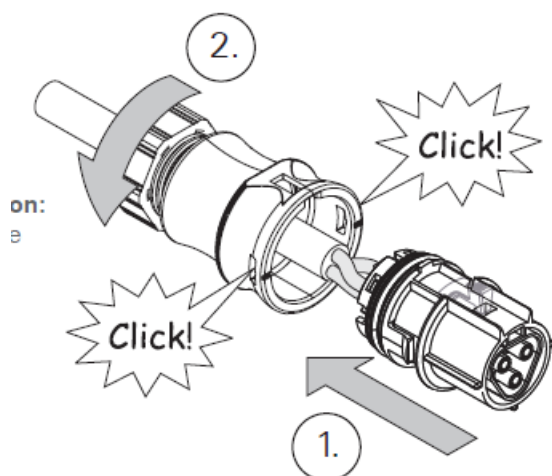
Push the rear part of the socket over the DC cable.
Press wire end sleeves onto the stripped strands.

Use the FemtoGrid DC cable and connect the individual 3 wires with the insert in turn as follow:



- **HOT** conductor on screw terminal with label + (**Red**)
- **Cold** conductor on the screw terminal with label - (**Blue**)
- **Neutral** conductor on the screw terminal with label 0 (**Black**)

Ensure that the wires are connected properly.
Snap the rear part of the socket onto the socket insert.
Tighten the screwed cable gland.



8. Commissioning

Determine correct AC cable

To avoid unnecessary disconnection from the grid, the conductor cross-section should be dimensioned such that cable losses do not exceed 1 % at nominal power. We advise to use cables with a diameter of 2,5 mm² or 4 mm².

Select a proper cable according national and/or local regulations.

Start up

The user will follow the next steps after starting up the first time.

- Start the inverter.
- adjust the language.
- adjust the country of installation.
- adjust the time.

Setting country

The first time the inverter is connected to the grid. The display of the inverter will show a selection menu where you can select the country of installation.

Select the correct country to start the inverter. After a selection is made, these settings cannot be changed anymore.



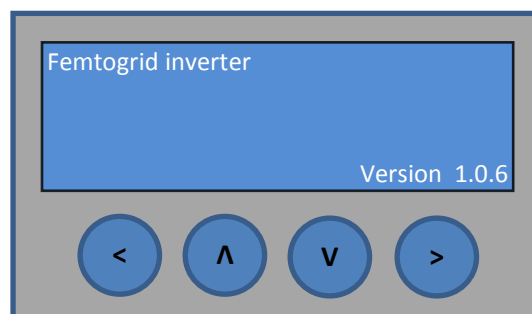
It's important to select the right country to fulfill the regulations of the country where the inverter is installed. If no country is selected the inverter stays in standby mode and does not convert energy.

9. User Menu

Menu manual

Boot screen

The boot screen is displayed during the startup sequence of the inverter. When the inverter finished its startup sequence the display will show the home screen.



Button function

Back None

Up Display previous value

Down Display next value

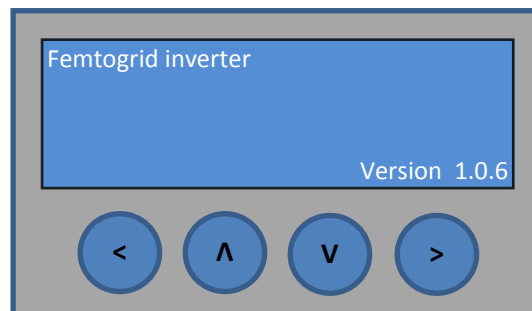
Enter Open menu

Homescreen

The home screen is the default screen the inverter will always return to.

The home screen can display several values such as: status of the inverter, total energy generated, energy generated today and current power.

To switch between values use the up/down buttons. To enter the menu of the inverter press the Enter button in the home screen.



Button function

Back None

Up Display previous value

Down Display next value

Enter Open menu

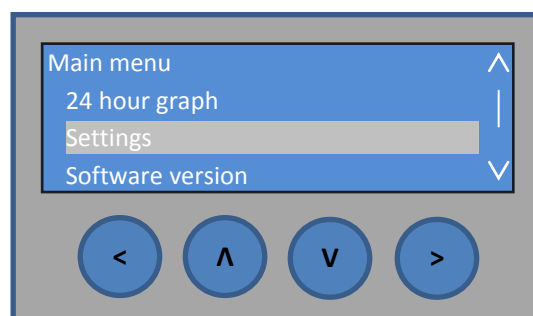
Menu screen

The inverter screen is equipped with a graphical menu interface in which various settings and functions can be accessed.

At the top of the screen the title of the menu is displayed regardless of the scroll position in the menu.

Below the menu title the menu items are displayed. The selected menu item is displayed with an inverted background color.

At the right of the screen the scrollbar indicates the position of the selected menu item in regard to all the items in the current menu.



Button function

Back Go to previous menu/home screen

Up Select the menu item above

Down Select the menu item below

Enter Select menu item

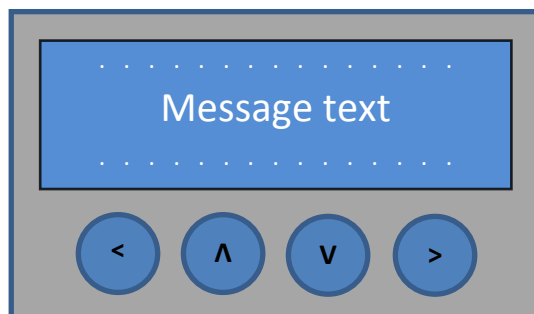
Push message

When the inverter has an important message to show to the user, it will use a push message.

In this screen the user is alerted of current events.

To exit the push message press the Enter or back button.

In case of an ongoing blocking event the user will not be able to exit the push message.



Button function

Back Exit push message

Up None

Down None

Enter Exit push message

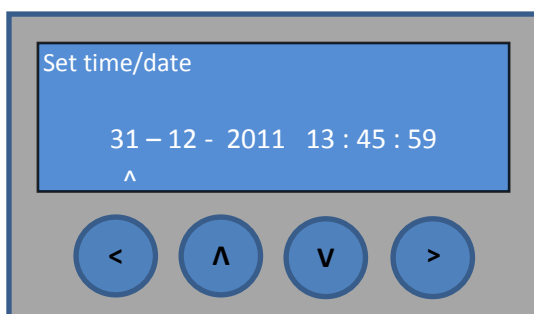
Time & date set screen

When the time & date set function is selected in the settings menu the user will be shown a time & date set screen.

At the bottom of the screen an indicator arrow is displayed indicating the current editable number. To raise the value of the number press the up button, to lower the value of the number press the down button.

To go to the next number press the enter button. When the last number is already selected the new time & date will be saved and the time/date interface will be exited.

To select the previous number or to exit the time & date screen press the back button.



Button function

Back Select previous number/exit screen

Up Raise value

Down Lower value

Enter Select next number/save and exit

Value edit screen

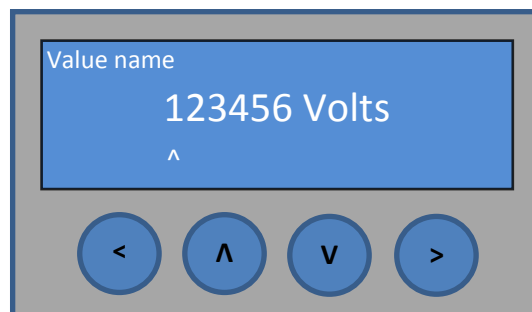
To enter or modify a value on the display screen the user is presented with an value edit interface.

In this screen the title of the value is displayed in the upper left corner of the screen. The actual value is displayed in the center of the screen optionally with its unit.

Below the value an indicator arrow is displayed the indicator arrow points to the current editable digit. To change the digit's value use the up/down keys.

To select the next digit press the enter button. When the last digit is already selected and the enter button is pressed the interface will save the value and exit.

To select the previous digit press the back button. When the first digit is already selected the interface will return.



Button function

Back Select previous digit/exit screen

Up Raise value

Down Lower value

Enter Select next digit/save value and exit

Menu map

- 24h energy graph
- Settings
 - Time/date
 - ZigBee Network
 - Network state
 - Nodelist
 - Step Up Power Optimizers off
 - Search network
 - Leave network
 - Language
 - English
 - Nederlands
 - Deutsch
 - Espagnol
 - Italiano
 - Francais
 - Country
 - Netherland (3)
 - Belgie (3)
 - Deutschland (3)
 - Espagnole (3)
 - France (3)
 - Italia (3)
 - United Kingdom (3)
 - Edit installer PIN (2)
 - Femtogrid (2)
 - Connected devices
 - Wind
 - Solar
 - Battery
 - External source 1
 - External source 2
 - External source 3
 - Femtogrid consumers
 - Priority level
 - Earth Monitor (2)
 - Ground voltage
 - Set high limit
 - Set neutral limit
 - Set low limit
 - Set response time
 - Retry on
 - AC Grid (2)
 - Pmax
 - Frequency
 - Phase
 - Supply to AC Grid
 - Draw from AC Grid
 - Pmax from AC Grid
 - Island detection
 - Generator backup
- Software versions
- System selftest (1)

(1) Only visible when country is set to Italy

(2) Requires installer PIN code (editable by installer)

(3) Requires manufacturer PIN code (contact Femtogrid Energy Solutions BV)

Error codes and warning messages

Error codes and/or warning messages: If the display presents an error code or warning message, please check the website www.femtogrid.com for references.

24h energy graph

The inverter shows a graphical presentation of the energy that is generated in the last 24 hours. This is only possible if the inverter is active for more than 24 hours.

Software versions

This menu item shows the software version of the inverter. Our customer service can ask for this version number during a service call.

Settings

In this menu item several settings can be changed. This includes time and date, Zigbee network, language, country and device settings and information.

The country settings can only be set the first time the inverter is installed. This can only be changed with a pin code in the factory or by an authorized person.

Time/date

Set here the time and date. This is important for data logging and warranty.

Zigbee Network

In this menu information and commands for the zigbee network can be given.

Edit installer PIN

If you have the installer PIN code you can change it here to avoid unauthorized access to the setting.

Femtogrid

With the installer pin code it is possible to view details and edit settings of connected devices on the Femtogrid.

In normal use, it is not necessary to enter this menu and mainly used for trouble shooting.

Earth Monitor

With the installer pin code it is possible to view details and change settings of the earth monitoring protection. This is only allowed by qualified personnel.

AC Grid

With the installer pin code it is possible to view details and change settings of the AC grid monitoring circuit. This is only allowed by qualified personnel and with permission of the grid operator.

System selftest

When this inverter is installed in Italy, the inverter has to perform a self-test before it connects to the grid. This menu item is only visible if the country Italy is selected. In the Italian installation manual this self-test is described in detail.

10. Practical notes

1. The maximum solar DC input to be connected without energy losses to the Inverter 2200 is 2550 Wdc. There is no risk to add more power to the inverter than its rating, the smart Femtogrid grid can handle powers up to the maximum of the cables used. If more power is connected it shut down some Power Optimizers to meet the power than the inverter can convert. For example; if 20 modules produce 150 W each total power is 3000 W. In this case the smart Femtogrid will turn off 3 modules and leave on 17 to convert (17 x 150W) 2550 W. When the solar power for each module drops to 100 W, the smart grid will turn on all Power Optimizers again and the power of all solar modules will converted to the inverter (20 x 100W = 2000W). In most European countries modules almost never reach their maximum power and it is very interesting to add more power than the inverters maximum.

2. We recommend to use 3 core Femtogrid DC cable 2,5 mm² for solar installations up to 4 kWp and 3 core Femtogrid DC cable 4 mm² for installations up to 8 kWp.

3. Power Optimizers are suitable for almost all solar modules. Our first version is suitable for modules that have a:

- Maximum power output < 300 Wp
- Maximum open circuit voltage < 42 V
- Maximum current < 10 A

4. Designing and installing the Femtogrid Solar System is easier than for conventional string systems. No need to worry about how many modules to connect in a string to be in range of the inverters MPP range or what the routing must be. Technical, it does not matter how the Power Optimizer are connected to each other (parallel system), however, for safety reasons pay attention with wiring, you should end with a female DC connector. Therefore we only include the end cab of a female connector and ask the installer to take notice how to connect prewired cables.

5. The Femtogrid Solar System is easy to expand. Of course the best value for money is to design your system around the maximum of the inverter but our system is designed to work wide power range and works also efficient in the lower power range. This gives the possibility to start with a small system and expand when the price of solar modules has dropped or if new products are available. The inverter can be used in a wide working range from 400W till 3000W. If you like to expand even more it is possible to connect two or more inverters in parallel on the DC Femtogrid side. They can be configured to work in a smart way to saves energy (=higher efficiency) by switching on and off inverters, depending on the amount of energy that needs to be converted.

11. Specifications

Femtogrid®	Single Phase inverter	
Type	2200ISO1	Dimension
Solar Input (DC)		
Maximum DC power	2550	W
Recommended PV power range	2400	Wp
Nominal DC operating voltage	360-400	Vdc
Minimum input voltage for rated output	380	Vdc
Maximum DC current	6,7	Adc
MPP tracker	@PV Power Optimizer	
Isolated transformer	Galvanic separated	
Mains Output (AC)		
Maximum AC power (@tamb 25° C)	2400	W
Nominal AC power	2200	W
Nominal output voltage range (country specific)	184-265	Vac
Maximum output current (continuous)	10,5	Aac
Maximum efficiency	96	%
Efficiency, European related (Euro ETA)	94,6	%
Power factor	1	
Frequency (country specific)	45-55	Hz
Standard Compliance		
EMC: Immunity	EN61000-4-2/3/4/5/6/11	
EMC: Emission	EN55022/EN60601-1-2	
	EN55022/EN61000-3-3	
Grid connection standards	NEN-EN 50438/VDE0126-1-1	
CE	yes	
RoHS/WEEE/REACH	yes	
Safety class	Class I	
Protection rating	IP31	
Temperature protection	> 80	°C
General		
Dimensions (WxLxH)	325x645x203	mm
Ambient temperature	0-40	°C
Weight	±38	kg
DC connections	Femtogrid/Wieland	Type
Output connections	Wieland	Type
Area of application	Indoor	

12. Certificates



ATTESTATION OF CONFORMITY

No. 74100365-ETD 11-0829

Issued to: Betronic Solutions B.V., Pedro de Medinalaan 11,1086 XK Amsterdam NL

For the product: FemtoGrid solar inverter

Trade name: FemtoGrid® inverter 2200

Type/Model: Solar inverter 2200ISO1

Ratings: Input: 360..400 Vdc, 6,7 A max, 0-2550 W
Output: 230 Vac, 50Hz, 10,5 A, 2400 W max

Manufactured by: Betronic Solutions B.V., Pedro de Medinalaan 11,1086 XK Amsterdam NL

Requirements: NEN-EN 50438:2008 Requirements for the connection of microgenerators in parallel with public low-voltage distribution networks.

Interface protection only examined for the following country specific requirements:

- Belgium
- Germany, including requirements defined in VDE0126:2006-02
- Spain, including requirements defined in RD1663:2000-09
- France
- United Kingdom, including requirements defined in G83/1:2003-9
- Italy
- The Netherlands

This Attestation is granted on account of an examination by KEMA, the results of which are laid down in a confidential file no. 74100365-ETD 11-0828, d.d. 29-04-2011

The examination has been carried out on one single specimen of the product, submitted by the manufacturer. The Attestation does not include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by KEMA is not the responsibility of KEMA

KEMA
Amhem, date 29-04-2011

A handwritten signature in blue ink, appearing to read "E. de Jong", is written over a faint, stylized blue line that forms a signature template.

Dr. Erik de Jong
Project Manager

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CERTIFICATE

ELECTROMAGNETIC COMPATIBILITY

Applicant : Betronic Solutions BV
 Contact person : Mr. Peter van der Hoek
 Address : Pedro de Medinalaan 11
 Postal code, Place : 1086XK Amsterdam
 Country : The Netherlands

Electrical apparatus : Solar inverter
 Trademark : FemtoGrid® Inverter 2200
 Type designation : Solar inverter 2200ISO1

Environment : Residential

EN 50438:2008 Requirements for the connection of microgenerators in parallel with public low-voltage distribution networks

EN 61000-6-3:2007 Generic emission standard for residential, commercial and light-industrial environments
EN 55022:2006 Emission - Class B

+A1:2007
EN 61000-3-2:2006 Harmonic current emissions

+A1:2009, +A2:2009
EN 61000-3-3:2008 Limitation of voltage fluctuations

EN 61000-6-1:2007 Generic immunity standard for residential, commercial and light-industrial environments

EN 61000-4-2:2009 Electrostatic discharge (ESD) immunity

EN 61000-4-3:2006 Radiated Electro-Magnetic field immunity

+A1:2008

EN 61000-4-4:2004 Electrical fast transient (EFT) immunity

+A1:2010

EN 61000-4-5:2006 Surge transient immunity

EN 61000-4-6:2009 Conducted Radio-Frequency disturbances immunity

EN 61000-4-8:2010 Power frequency magnetic field immunity

The undersigned declares that the described product meets the essential EMC requirements of the standard EN50438 and the essential requirements of the EMC directive 2004/108/EC, based on a non-recurrent examination. The test results are recorded in the KEMA test report with reference 74100365-ETD 11-0828.

DEKRA Certification B.V.
 (Notified Body EMC)
 Arnhem, 12 April 2011

Ing A.T. van der Meijden
 Certification Manager EMC

Certificate nr. 2143652.0551-EMC

Integral publication of this certificate and associated reports may be used in its original form only.

All testing, inspection, auditing and certification activities of the former KEMA Quality are an integral part of the DEKRA Certification Group.

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13. Company information

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